ON

HORN AND TORTOISESHELL.

By THE SECRETARY.

Read 5th June, 1832.

The subject of the present evening's illustration is the manufacture of horn and of tortoiseshell, to which I shall add some particulars respecting whalebone — a substance which, in its physical and chemical properties, bears a great resemblance to horn.

In the English language we have only one word to express two quite different substances — namely, the branched bony horns of the stag genus and the simple laminated horns of the ox genus, and other kindred genera.

The bony horns are called in French *bois*, from their likeness to the branch of a tree: they are annually renewed, and are peculiar to the male sex, except in the reindeer, the females of which likewise have horns, though not nearly so large as those of the male.

The other sort of horn, to which the French appropriate the term *corne*, and which is the subject of our present inquiry, is found in the ox, the antelope, the goat and sheep kinds. These are never branched or palmated, but are always of a simple conical figure, more or less curved, and, in some of the antelopes, spirally

twisted: they are found in both sexes, but, in the goats and sheep, are much larger in the male than in the female.

In all these animals, a bony core, of a loose texture and conical figure, rises from the bone of the forehead, covered by a permanent vascular membrane, from the surface of which are produced or secreted thin layers of horn in constant succession. It is supposed that one layer, or rather one set of layers, is produced every year; but, as the former layer remains closely adherent to the new one, such horns are permanent, lamellar in texture, and exfoliate only very slowly from the outside by exposure to weather and friction. The structure of such horns is that of a number of cones or sheaths inserted into one another, the inner of which lies on the vascular membrane that covers the bony core or base. The tip of the horn — namely, that part which projects beyond the core — is very dense, and the layers of which it is composed can hardly be distinguished, whereas the lower parts are of a looser structure, and the layers may readily be seen from the successive terminations of them forming prominent rings, which are very observable on the lower part of the horn. Horn itself is quite insensible, like the finger-nail; and therefore the tip may be cut off while the animal is alive without giving any pain; but if the section is made so low down as to include any part of the core, blood follows, and the animal seems to suffer greatly.

But it is not merely in the defences projecting from the forehead of the genera already mentioned that horn occurs: in the form of nails, claws, or hoofs, it protects and arms the extremities of the toes in all warm-blooded animals, and constitutes the leg-spurs of the cock and

other gallinaceous birds. In the form of scales it covers the body of the pangolin, of the armadillo, of the lizard and serpent tribe, and of most fishes, and incloses the tortoises in a kind of plate-armour. It also supplies the hairy covering of the land mammalia, from the fine down of the beaver to the bristles of the wild boar, the horny hair of the elk and the musk, and the spines of the hedgehog and porcupine. The horn of the rhinoceros is not formed upon a bony core, but is merely an aggregation of flattened hairs or bristles adhering by their sides, and presenting longitudinal pores or interstices of considerable magnitude at the base of the horn, and which become smaller towards the point; these interstices in the live animal are filled with a pulpy matter. All feathers likewise, from the plumes of the ostridge to the quills with which we write, and the wing-spurs of the cassowary, are only modifications of horn; so that it may be considered as the general covering of the most highly organised animals.

Horn also occurs, where it would not at first be looked for, in the form of plates hanging down from the palate or roof of the mouth in the Greenland whale, and in those other cetaceous animals that are destitute of teeth. This modification of it goes by the common name of whalebone, of which I shall speak more at large hereafter.

The membranous parts of the animal body are also exceedingly similar to, if not identical with, horn, both in structure and chemical composition: such are the cuticle or scarf-skin which covers the whole body, and separates from the true or sensitive skin on the application of a blister. The intestines, the bladder, and other thin parts which, on drying, become hard and transparent, are also

of the same kind; as likewise are the air-bladders of fish: but these latter also contain jelly.

Certain animal fluids also bear a close analogy to horn in their chemical composition: such are the serum of blood and the white of egg. Both these substances coagulate at a heat less than that of boiling-water, and when afterwards dried, at the common atmospheric temperature, become yellow, transparent, hard, and bear a perfect resemblance to horn, except that their texture is compact, not laminated.

To all the substances above enumerated, chemists give the general name of albumen; and it is distinguished by the following properties from jelly and from fibre, the two other principal organic elements of animal bodies. It does not dissolve in boiling water and fix, on cooling, as jelly does, and by its long resistance to putrefaction it is distinguished from fibre. I may also mention that, when exposed to a decomposing heat in close vessels, it produces a large quantity of that gaseous compound which forms the base of prussic acid; on which account it is that hoofs and the refuse parts of horn are in great request among the manufactures of Prussian blue.

Almost the only kinds of horn that are the subject of manufacture are those of the bull and cow, and the hoofs of these animals; the horns of the bullock being thin, and of a very coarse texture, are used only for the most ordinary purposes. Our domestic supply is by no means equal to the demand, so that great quantities are imported from Russia, the Cape of Good Hope, and South America.

The first process is the separation of the true horn from the bony core on which it is formed: for this purpose the entire horns are macerated in water for a month

or six weeks, according to the temperature; during this time the membrane which lies between the core and the horn is destroyed by putrefaction, so that the core becomes loose, and can easily be extracted. The cores are not thrown away, but are burnt to ashes, and in this state form the best material for those small tests or cupels employed by the assayers of gold and silver.

The next process is to cut off with a saw the tip of the horn, that is, the whole of its solid part, which is used by the cutlers for knife-handles, is turned into buttons, and is applied to sundry other purposes. The remainder of the horn is left entire or is sawn across into lengths, according to the use to which it is destined. Next, it is immersed in boiling water for half an hour, by which it is softened; and, while hot, is held in the flame of a coal or wood fire, taking care to bring the inside as well as the outside of the horn, if from an old animal, in contact with the blaze. It is kept here till it acquires the temperature of melting lead or thereabouts, and, in consequence, becomes very soft. In this state it is slit lengthways by a strong-pointed knife, like a pruning-knife, and, by means of two pairs of pincers applied one to each edge of the slit, the cylinder is opened nearly flat. These flats are now placed on their edges between alternate plates of iron, half an inch thick and eight inches square, previously heated and greased, in a strong horizontal iron trough, and are powerfully compressed by means of wedges driven in at the ends.

The degree of compression is regulated by the use to which the horn is to be afterwards applied: when it is intended for leaves of lanterns, the pressure is to be sufficiently strong (in the language of the workmen) to break the grain: by which is meant separating, in a

slight degree, the laminæ of which it is composed, so as to allow a round-pointed knife to be introduced between them, in order to effect a complete separation.

The plates thus obtained are laid one by one on a board covered with bull's hide, are fastened down by a wedge, and are then scraped with a draw-knife having a wire-edge turned by means of a steel rubber; when reduced to a proper thickness and smoothed, they are polished by a woollen rag dipped in charcoal dust, adding a little water from time to time, then are rubbed with rotten-stone, and finished with horn shavings. The longest and thinnest of the films cut off by the draw-knife, when dyed and cut into various figures, are sold under the name of sensitive Chinese leaves (being originally brought from China), which, after exposure to a damp air, will curl up as if they were alive when laid on a warm hand or before the fire.

For combs, the plates of horn should be pressed as little as possible, otherwise the teeth of the comb will split at the points. They are shaped chiefly by means of rasps and scrapers of various forms, after having been roughed out by a hatchet or saw: the teeth are cut by a double saw fixed in a back, the two blades being set to different depths, so that the first cuts the tooth only half way down, and is followed by the other which cuts to the full depth; the teeth are then finished and pointed by triangular rasps. If a comb or other article is too large to be made out of one plate of horn, two or more may be joined together by the dexterous application of a degree of heat sufficient to melt but not decompose the horn, assisted by a due degree of pressure; and when well managed, the place of juncture cannot be perceived. The Chinese are remarkably skilful in this kind of work,

as may be seen in the large globular lantern in the Museum at the East India House, about four feet diameter, composed entirely of small plates of coloured and painted horn. Horn combs are made in London, in York, and in many other English towns; but the chief manufactory of them is at Kenilworth, in Warwickshire.

If a work in horn, such as one of the large combs worn by women, is required to be of a curved or wavy figure, it is finished flat, and is then put into boiling water till it becomes soft, and is immediately transferred to a die of hard wood, in which it is cautiously pressed, and remains there till cold.*

Horn combs ornamented with open work are not made in this country, because the expense of cutting them would be more than the price of the article would repay; but great numbers of them are imported from France. These, however, are not cut, but pressed in steel dies made in London for the French manufacturers; and from an examination of these combs, it is evident that the material must have been in a soft state, approaching to fusion, when put into the die. On referring to French authorities, I find it stated that horn steeped for a week in a liquor, the active ingredient of which is caustic fixed alkali, becomes so soft that it may easily be moulded into any required shape. Horn shavings subjected to the same process become semi-gelatinous, and may be pressed in a mould into the form of snuff-boxes and other articles. Horn, however, so treated becomes hard and very brittle, probably in con-

* Combs among the Romans were made of box-wood.

Quid faciet nullos hic inventura Capillos
Multifido *Buxus* quæ tibi dente datur.—MART. *Epig.* xiv. 25.

sequence of its laminated texture being obliterated by the joint action of the alkali and strong pressure.

Drinking cups of horn are thus made. The horn being sawn to the required length is scalded and roasted over the fire, as already described; but instead of being slit and opened, is placed while hot in a conical mould of wood; a corresponding plug of wood is then driven hard in, to bring the horn to shape. Here it remains till cold, and is then taken out and fixed by the large end on the mandril of a lathe, where it is turned and polished both inside and outside, and a groove, or chime as the coopers call it, is cut by a gage-tool within the small end for receiving the bottom. The horn is then taken off the lathe and laid before the fire, where it expands and becomes somewhat flexible; a round flat piece of horn, of the proper size (cut out of a plate by means of a kind of crown-saw), is dropped in, and forced down till it reaches the chime, and becomes perfectly fixed in this situation and water-tight by the subsequent contraction of the horn as it cools. Capt. Bagnold informs me that he has seen in South America a nest of such cups turned to a thickness not exceeding that of a card, and accurately fitting into each other, the outer one holding about a pint and the inner one little more than an ounce.

Horn is easily dyed by boiling it in infusions of various colouring ingredients, as we see in the horn lanterns made in China. In Europe it is chiefly coloured of a rich, red brown, to imitate tortoiseshell, for combs and inlaid work. The usual mode of effecting this is to mix together pearl-ash, quicklime, and litharge, with a sufficient quantity of water and a little pounded dragon's-blood, and boil them together for half an hour. The compound is then to be applied hot on the parts that are required to be coloured,

and is to remain on the surface till the colour has struck: on those parts where a deeper tinge is required, the composition is to be applied a second time. For a blacker brown, omit the dragon's blood. This process is nearly the same as that employed for giving a brown or black colour to white hair; and depends on the combination of the sulphur, which is an essential ingredient in albumen, with the lead dissolved in the alkali, and thus introduced into the substance of the horn.

In very early times bows were made of horn. Homer describes the bow of Pandarus (*Il.* iv.) as made of the two horns of a wild goat united base to base, reduced into proper form and polished, and then tipped with gold. The bow of Ulysses was also of the same material (*Odyss.* xxi.). The long-bow of the English archers was, I believe, entirely of wood; but in the East, even at the present day, bows are made entirely, or in part, of horn. To the kindness of Colonel Taylor I am indebted for the opportunity of exhibiting to you a Chinese bow, made partly of wood and partly of buffalo's horn. The same gentleman likewise informs me, that he has bought in Calcutta pretty good bows made entirely of buffaloes' horn; but the best Indian bows, those namely of Lahore, are made of horn combined with wood, and strapped round with sinew. Horn lanterns, were also used by the ancients; for we find one mentioned in the *Amphitryo* of Plautus,* and in an epigram of Martial.† Pliny‡ also

* Quo ambulas tu, qui Vulcanum in cornu conclusum geris?
Amphitry. Act i. l. 185.

† Dux Laterna viæ clausis feror aurea flammis
Et tuta est gremio parva lucerna meo.—MART. *Epig.* xiv. 61.

‡ Cornua apud nos in laminas secta translucent, atque etiam lumen inclusum latius fundunt; multasq. alias ad delicias conferuntur, nunc tincta, nunc sublita, nunc quæ cestrotæ picturæ genere dicuntur.—*Hist. Nat.* xi. 45.

speaks of horn-lanterns, and says that various other ornamental articles were made of dyed and painted horn.

Horn was also used as we now employ glass in windows; for which, however, it is not very well adapted, as plates thin enough to be transparent would soon warp, and be corroded by exposure to the weather.*

Horns are also of very ancient use as musical instruments: the true bugle-horn was made of the horn of the urus, or wild bull, tipped with silver, and slung in a chain of the same material.

Another use to which horn has been applied is as a material for defence. I remember to have seen, several years ago, a complete suit of scale-armour made of horn. It was said to have come from Arabia, and seemed very capable of turning the edge of a sword or a pistol-bullet.

I now proceed to mention some particulars respecting TORTOISESHELL.

The animal which produces this beautiful substance is a marine tortoise, called the *Testudo imbricata*, or hawksbill turtle. Its Latin name is derived from the mode in which the scales on its back are placed, overlapping one another like the tiles on the roof of a house. In this circumstance, it seems to differ from almost all others of its genus; the scales of other tortoises, both those which are land animals and those which inhabit water, either salt or fresh, generally adhering to each other by their edges, like a piece of inlaid work. These plates, in all the tortoises, cover the bony arch of the back formed by the ribs and spine united into one immovable convexity

* Corneum specular.—TERTULL. *de Animâ*, liii.

by flat bones stretching from rib to rib, and uniting insensibly with the spine.

The hawksbill turtle is a native of the torrid zone, and is found in the Indian seas as far as New Zealand, on the coast of Africa, on that of New Granada, in South America, and in many parts of the West Indies, especially on the Mosquito shore and the promontory of Yucatan. Its usual length is about three feet; but specimens have sometimes been found five feet long, and weighing five or six hundred pounds.

The number of plates produced by each tortoise is thirteen; namely, five along the back, and a row of four others on each side: there are also twenty-five, much smaller ones, forming the margin of the shell. The size and thickness of the plates depend on the magnitude and age of the animal, a fresh layer being produced every year; and at the margin of the large plates may be seen distinctly the edges of the layers as they thin off in succession. Sometimes, however, large plates are met with, so thin as to consist, apparently, of only a single layer. The cause of this anomaly I do not know; but some of the dealers in this article have an opinion that these thin plates are the produce of full-grown tortoises that have been stripped of their plates the year before, either purposely or by accident.

The plates are separated by placing the arch of the shell (all the other parts having been removed) over a fire, which soon causes them to start from the bone, by the help of a slender knife. The price of rough tortoiseshell depends on its quality, that is, on its thickness, and the vividness and distinctness of the colours. The present price for fine shell is about three guineas a pound. Not unfrequently the plates are considerably injured by bar-

nacles, limpets, and other shell-fish, which fix themselves on the animal while alive, and prevent the growth of the tortoiseshell on that part which they occupy. Sometimes one or more of the plates will be of a plain yellow colour; and such are in great request among the Spanish ladies, who will give twelve or fourteen dollars for a comb of plain tortoiseshell, while a similar one of the mottled kind will not sell for more than six dollars. The belly-plates of the tortoise are also yellow, and sometimes clear enough to be made use of.

The general mode of manufacturing tortoiseshell is the same as I have already described when treating of horn. It is softened by boiling in water; but mere water takes away much of the colour: an addition of common salt prevents this injury; but if too strong a brine is used the shell will be very brittle. Two or more pieces of tortoiseshell may be joined by laying their scraped or thinned edges together, and then pressing them between hot iron. If, however, the heat is too great, the colours are much deepened so as to become almost black, as is the case with moulded snuff-boxes; for tortoiseshell being less fusible than horn, cannot be made soft enough to be moulded without some injury to the colour. Accordingly the manufacturers, at least in England, never attempt to produce tortoiseshell combs with ornamental open work by means of dies, but in the following manner.

A paper being pasted over the tortoiseshell, the pattern is drawn on the paper, and is then cut out by means of drills and fine saws: the paper is then removed by steeping in water, and the surface of the pattern is finished by the graver.

In making small side-combs, it is found worth while, in order to save a costly material, to employ a machine

consisting of a cutter working straight up and down, and of a bed (on which the shell is laid), to which is given a motion advancing by alternate inclination, first to one side and then to the other. By this means the teeth of two combs are cut at the same time, those of the one occupying the intervals of the other. Such combs are called *parted,* the saw not being used upon them ; and are often made of fine stained horn instead of tortoiseshell. Tortoiseshell is also used for inlaying tables, cabinets, and other ornamental articles, a metallic foil being placed below it to give lustre and colour. This employment of it appears to be coming at present considerably into fashion.

Among the Romans of the Augustan age, this taste was not so much a fashion as a fury. The frames of the couches on which they reclined at table were covered with the largest and most beautiful plates that could be procured of tortoiseshell ; * and it was employed for various other similar purposes : but I am not aware that it was ever used by them as a material for combs. It was brought by Indian and Arabian traders from the islands in the Indian Sea to Adulis,† in Abyssinia, together with ivory, rhinoceroses' horns, and hippopotamuses'

* Attonitus pro
Electro signisq. suis Phrygiâ columnâ
Atq. Ebore, et latâ Testudine.—JUVEN. xiv. 306.
Ut Testudineo tibi, Lentule, conopeo
Nobilis Euryalum myrmillonem exprimat infans.—*Ibid.* vi. 80.
Gemmantes primâ fulgent Testudine lecti.—MART. xii. 66.
Et Testudineum mensus quater hexaclinon.—*Ibid.* ix. 60.
Varios—pulchrâ Testudine postes.—*Georg.* ii. 463.

† Opidum Aduliton — maximum hic emporium Trogloditarum, etiam Æthioprum.—Deferunt plurimum Ebur, Rhinocerotum cornua, Hippopotamorum coria, chelyon Testudinum.—PLIN. *Hist. Nat.* vi. 34.

hides. Here it was purchased by Egyptian merchants, was transmitted to Alexandria, and thence passed to Rome and the other great cities of the empire. For modern uses, thick tortoiseshell is more valuable in proportion than thin; but among the Romans, where it was used only for inlaying, veneers were cut out of it. This art was the invention of one Corvilius Pollio, a man, as Pliny ‡ says, of singular sagacity in all things that ministered to prodigal luxury.

WHALEBONE, as I have already stated, may be considered as a kind of horn; which latter substance it resembles perfectly, both in its chemical and principal physical properties, and is particularly interesting as forming the transition from horn to hair.

It is the substitute for teeth in the Greenland whale, and in the black southern whale; but is not found in any of the cetaceous animals that have teeth.

The food of the Greenland whale is a small crustaceous animal not so large as a common shrimp; and the whalebone forms the apparatus by which this huge animal secures the minute prey that he lives on. From the roof of the mouth hang down on each side the tongue about three hundred blades of whalebone, all the blades on one side being parallel to each other, and at right angles to the jaw-bone. On account of the arched form of the roof of the mouth, the blades about the middle of

* Testudinum putamina secare in laminas, lectosque et repositoria his vestire, Corvilius Pollio instituit, prodigi et sagacis ad luxuriæ instrumenta ingenii.—PLIN. *Hist. Nat.* ix. 13.

the series are the longest, and they diminish gradually towards each end. The average length of the middle blades is about nine feet; but they have occurred of the length of fourteen or fifteen feet. These blades hang down in the mouth so that the hairy side shall be the innermost; the hairs forming a net or filter through which the water escapes, leaving the shrimps behind.

The surface of the blade is compact, and susceptible of a high polish by mere friction. Its texture is lamellar in the direction of its breadth, so that it easily splits and divides in this direction, but not in that of the thickness of the blade: the middle of the blade is of a looser texture than the rest, and is technically called the grain, being composed of coarse, bristly hairs. The general colour of whalebone is a dusky greyish black, intermixed with thin strips, or layers of a paler colour, which are often almost white—very rarely the entire flake is milk-white.

The preparation of the whalebone for use is very simple. It is boiled in water for several hours, by which it becomes soft enough to be cut up, while hot, in lengths of different dimensions, according to the use to which it is to be applied; or, by means of a compound guarded knife, is cut into fibres for brushes, which are at present extensively used in stables for the first process in cleaning a horse. Whalebone that has been boiled, and has become cold again, is harder and of a deeper colour than at first; but the jet-black whalebone has been dyed. The principal consumption of whalebone at present is for stretchers to umbrellas and parasols: it is also used, though not so much as formerly, in giving stiffness to women's stays. Whips are also made of platted whale-

bone, both black and white: the latter are very beautiful. White whalebone has also been made into ladies' bonnets, and likewise into artificial flowers, as its texture is well adapted to this purpose; and it will, by the usual dyeing processes, take very bright and durable colours.